Measurement of antenna radiation resistance and reactance

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At his installation as RSGB President for 1979, the author of this article stressed the need for more simple articles to be submitted for publication in Radio Communication. *This article is intended to lead the way and show what he had in mind.*

HAVE readers ever found it difficult to feed an experimental antenna satisfactorily or to find an explanation for the high swr on a feedline? If so, the information needed is the radiation resistance and reactance values (R or ±jX) either at the antenna or at the input end of the feedline. In the latter case, if the length of line is known then the values can be plotted on a Smith's Chart to give the R±jX at the antenna. For those amateurs who are unfamiliar with these charts and their uses, articles describing them were published in *Radio Communication* in January and December 1977. Alternatively, one can make the feedline an electrical half-wave so that the value at the antenna will be repeated at the input end of the feedline.

Very simply, if one wishes the antenna to be resonant one is aiming for 0jX, so if the measurement is positive the antenna is too long, and, conversely, if the reading is negative the antenna is too short. Armed with this information, together with the radiation resistance, the design of matching networks is relatively simple.

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Components list

R1	5×220Ω 1W carbon	C1,2,3,5,6	0·001μF disc ceramic
R2	12Ω 2W carbon	C4 3·5MHz	1,000pF silver mica
R3,5,6 7,8	1·5MΩ 0·5W carbon	7MHz	560pF silver mica
R4	50Ω 2W carbon	14MHz	390pF silver mica
		21MHz	180pF silver mica
		28MHz	100pF silver mica
D1,2,3,4,5	OA90		
S1	1-pole 5-way rotary		
Sockets	2 off PL259 coaxial		
Terminal tag strips	3 off 5-way, centre earth		
Insulation terminals	1 red, 1 black		

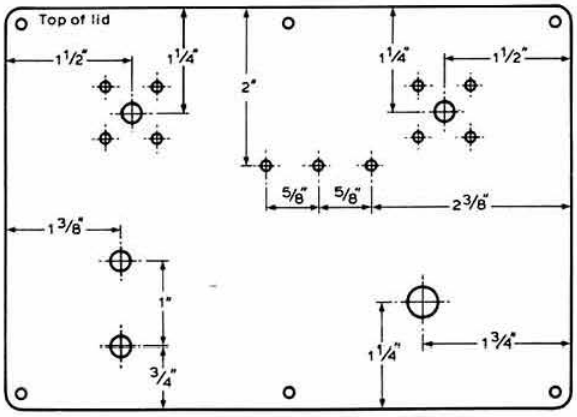

Fig 2. Drilling plan of die-cast box lid

Laboratory instruments are very expensive, but the antenna bridge to be described is simple and cheap to build and will provide sufficiently accurate measurements for most amateur purposes. It is not the author's intention in this article to give a technical explanation of how the unit operates, but rather to describe its construction and use. The unit was described in *QST* June 1965, and a technical explanation is given in that article.

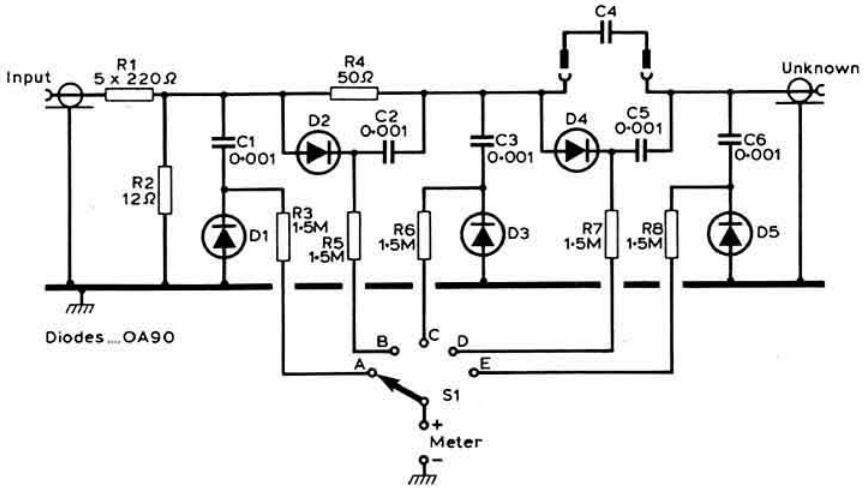

Fig 1. Circuit diagram of the bridge

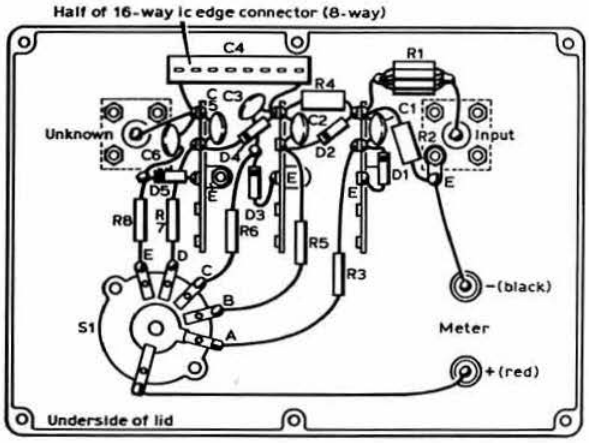

Fig 3. Component layout on underside of lid

The antenna bridge (Fig 1) was built in a die-cast aluminium box 6·75 by 4·75 by 2·25in, with the components mounted on the lid (Figs 2, 3). The socket to take C4 (which must be changed for each band) was made by cutting a 16-way ic edge connector in half (Fig 4), but 8-way connectors are also available.

Measurement procedure

1. Insert the appropriate capacitor (C4) in the socket.
2. Connect the transmitter to INPUT and the antenna or unknown to the UNKNOWN socket.
3. Connect a vtvm to the meter terminals set to the 1·5V range, and with S1 in position B adjust the transmitter for 0·5V.

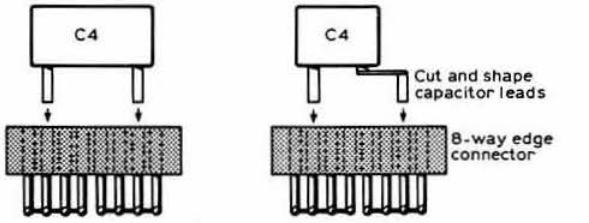

Fig 4. Leads of C4 to be cut and shaped as shown to plug into edge connector

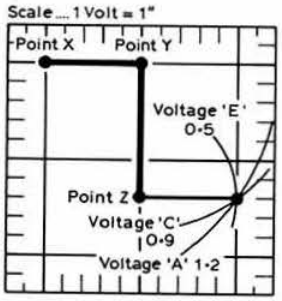

Fig 5. Intersecting areas of voltage

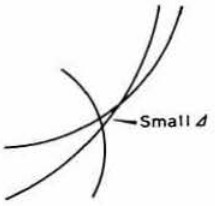

Fig 6. A "triangular" intersection

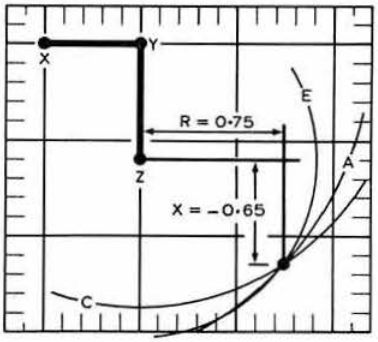

Fig 7. Measurement of reactance and radiation resistance

(Read this as 50Ω. One can use any other voltage scale and adjust the transmitter for 5 or 50V).

4. Quickly record the voltages at switch positions A, C, D and E, and finally check that position B is still 0·5V.
5. On a piece of graph paper (Fig 5), mark an origin point X, and draw a horizontal line from this to point Y; this represents voltage B. From point Y draw a vertical line to point Z (using the same unit scale); this represents voltage D.

Using point X as the centre, draw an arc corresponding to voltage A; using point Y as the centre, draw an arc corresponding to voltage C; and using point Z as the centre, draw an arc corresponding to voltage E.

6. The three arcs should intersect in a common point, but occasionally a *small* "triangle" will be formed (Fig 6) and the centre of this should be taken as the common point. Draw a horizontal line from point Z, and then draw a vertical line from the arc intersection to cross the horizontal line (Fig 7).

Measure the distance along the horizontal line from Z to where it meets the vertical line; this will give the radiation resistance. Measure the vertical line from the arc intersection to the horizontal line, this will give reactance. Remember, above the horizontal from point Z is positive jX, while below it is negative jX (Fig 8).

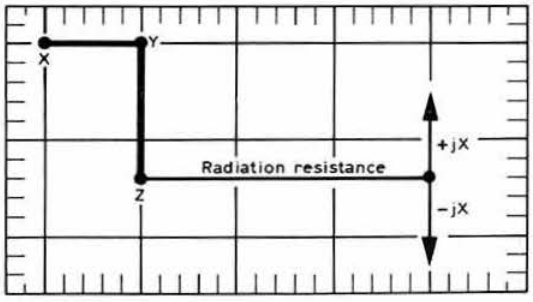

Fig 8. Positive and negative reactance above and below point Z respectively

It seems complicated but is very simple to do after one or two trial runs. With swr above 3 to 1, the angles of the diagram may be rather narrow, introducing an error in measurement. At a voltage below 0·25V the diodes give a square law reading not consistent with higher readings. □